

BACKGROUND

Relevant Field

[0024] The present disclosure relates to monitoring, regulating, or controlling fluid flow. More particularly, the present disclosure relates to a system, method, and apparatus for monitoring, regulating, or controlling fluid flow, for example, for use in medical applications such as intravenous infusion therapy, dialysis, transfusion therapy, peritoneal infusion therapy, bolus delivery, enteral nutrition therapy, parenteral nutrition therapy, hemoperfusion therapy, fluid resuscitation therapy, or insulin delivery, among others.

Description of Related Art

[0025] In many medical settings, one common mode of medical treatment involves delivering fluids into a patient, such as a human, animal, or pet. The need may arise to rapidly infuse fluid into the patient, accurately infuse the fluid into the patient, and/or slowly infuse the fluid into the patient. Saline and lactated ringers are examples of commonly used fluids. Such fluids may be used to maintain or elevate blood pressure and promote adequate perfusion. In the shock-trauma setting or in septic shock, fluid resuscitation is often a first-line therapy to maintain or improve blood pressure.

[0026] Delivery of fluid into the patient may be facilitated by use of a gravity-fed line (or tube) inserted into the patient. Typically, a fluid reservoir (e.g., an IV bag) is hung on a pole and is connected to the fluid tube. The fluid tube is sometimes coupled to a drip chamber for trapping air and estimating fluid flow. Below the fluid tube may be a manually actuated valve used to adjust the flow of fluid. For example, by counting the number of drops formed in the drip chamber within a certain amount of time, a caregiver can calculate the rate of fluid that flows through the drip chamber and adjust the valve (if needed) to achieve a desired flow rate.

[0027] Certain treatments require that the fluid delivery system strictly adhere to the flow rate set by the caregiver. Typically, such applications use an infusion pump, but such pumps may not be used in all situations or environments.

SUMMARY

[0028] Briefly, and in general terms, the present disclosure relates to a system, method, and apparatus for monitoring, regulating, or controlling fluid flow, for example, for use in medical applications such as intravenous infusion therapy, dialysis, transfusion therapy, peritoneal infusion therapy, bolus delivery, enteral nutrition therapy, parenteral nutrition therapy, hemoperfusion therapy, fluid resuscitation therapy, or insulin delivery, among others. More particularly, the present disclosure relates to a fluid flow meter for monitoring the flow of fluids associated with a patient, a valve for regulating the flow of fluid associated with the patient, and/or a fluid flow meter coupled to a valve (e.g., arranged in a closed-loop, open-loop, or feedback configuration) to monitor, regulate and/or control the use of fluid associated with the patient.

[0029] In some embodiments of the present disclosure, a flow meter includes one or more optical sensors to monitor the flow of fluid within a tube, for example, using an image sensor to monitor drops within a drip chamber attached to the tube. The flow meter may be a stand-alone device, may be used in conjunction with either a pump or a valve, or both,

and/or may be used to provide feedback to any electronic device. The flow meter may be remotely controlled, e.g., by a monitoring client, a remote communicator, a smart phone, a computer, etc. The flow meter may measure the average flow rate, an instantaneous flow rate, a drop volume, a drop growth rate, or other parameter related to fluid flow.

[0030] The flow meter may use the flow rate or parameter related to fluid flow to: (1) display the flow rate or parameter on a screen, (2) provide feedback, such as the flow rate or parameter related to fluid flow (wirelessly or via wires), to an infusion pump such as a peristaltic pump, (3) provide feedback to a monitoring client or remote monitoring client such as a smart phone, (4) issue alarms when the flow rate or parameter related to fluid flow is outside a predetermined range, (5) issue an alarm with the flow rate or parameter related to fluid flow is above a predetermined threshold, (6) issue an alarm when a free flow is detected, (7) communicate alarms to a pump, a monitoring client, or a remote monitoring client, (8) instruct a valve to stop fluid flow when a free flow is detected, an alarm is issued, and/or the flow rate or parameter related to fluid flow is above a threshold or is outside of a predetermined range, and/or (9) broadcast the flow rate or parameter related to fluid flow.

[0031] In some embodiments described herein, a valve regulates the flow of fluid associated with a patient. The valves disclosed herein may be manually actuated or may be actuated with an actuator (or both). The valve may be used with or without a pump, with or without a flow meter, and/or may be a stand-alone device. The valve may be remotely controlled, e.g., by a monitoring client, a remote communicator, a smart phone, a computer, etc. The valve may compress a tube along a portion that is substantially greater than the diameter of the tube, e.g., 2 times greater, 5 times greater, 10 times greater, etc.

[0032] The valve may be made of two or more pieces that compress the tube or may be made of a single piece that compresses the tube as the piece is moved or deformed. The two or more pieces and/or the single piece may be made using injection molding, ultrasonic welding, using multiple pieces that are glued or molded together, or the like. Each of the two or more pieces may be made by one or more subparts that are attachable to each other either permanently or temporarily. The single piece may be made by one or more subparts that are coupled together either permanently or temporarily, e.g., using ultrasonic welding, gluing, latching, or other technique. The pieces may be plastic, metal, an alloy, a polymer, or other material.

[0033] In some embodiments of the present disclosure, a flow meter is coupled to a valve to regulate fluid flow, e.g., fluid flow into a patient. The flow meter coupled to the valve may be used in lieu of a pump, such as a peristaltic infusion pump. The flow meter and valve combination may be remotely controlled, e.g., by a monitoring client, a remote communicator, a smart phone, a computer, etc. or may be remotely monitored. A monitoring client may control the flow meter or valve, may be a relay between the flow meter and valve, may monitor the operation of the flow meter or valve, may communicate information related to the flow meter or valve to a server, and/or may not be used in the system.

[0034] The flow meter may monitor the flow of fluid and make adjustments, directly or indirectly, to a valve or a pump (e.g., an infusion pump). The flow meter may alarm when it detects free flow conditions, determines if the flow